
Space Weather Technical Forecast

Issued on Wednesday, 20 July 2022 at 01:21 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: G1/Minor Storms likely with CH02 and CH01 fast winds arrivals, most likely day 3 (22nd). Chance of M-flares (R1-R2 Radio blackouts). Chance of Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the last 24 hours, with nine sunspots on the visible disc. None of the regions have been significantly active, with only low energy C-class flares observed. The only growth observed was in two small new emergent regions in the northeast quadrant. There are no Earth-directed CMEs.

Solar Wind / Geomagnetic Activity: The solar wind as observed at L1 was indicative of a CME arrival, perhaps alongside a weak fast wind enhancement from CH03. Solar wind speeds were slightly elevated, mainly at 420-500 km/s, but peaking at around 525 km/s around 19/1200 UTC. Initially above average density fell below average after 19/1400 UTC. Initially turbulent total IMF (interplanetary magnetic field) Bt, between 7-16 nT, rose to 13nT around 19/0430 UTC, before then smoothly and gradually declining to just under 9 nT by 20/0000 UTC. The north-south direction was initially variable between +15 nT and -11 nT, but became persistently negative from 19/0400 UTC, and smoothly weakened from 19/1100 UTC. The phi angle was variable. Geomagnetic activity was Unsettled to Active with one G1/Minor Storm interval (19/1200-1500 UTC).

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16, was at background levels. High energy electron flux has been low throughout much of the period, but increased to Moderate from 19/2130 UTC. The 24-hour integrated electron fluence was below the Active threshold (1e8 integrated pfu), falling to 7.27e6 at 20/0000 UTC.

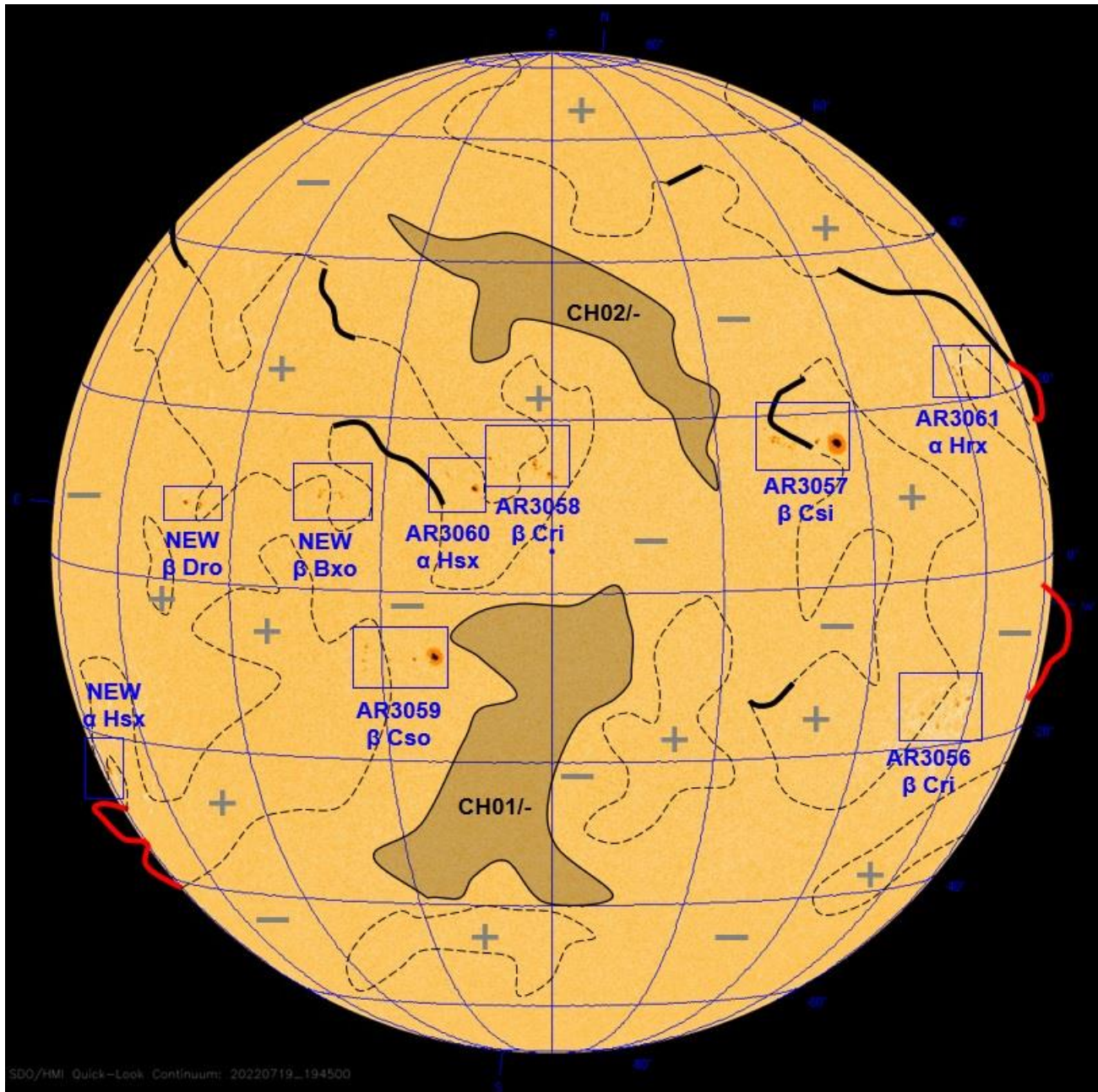
Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low, with a chance of rising to Moderate from any M-flares that occur due to the number of sunspot regions on the visible disc.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Current elevated solar winds are expected to ease day 1 (20th) and day 2 (21st) before a further enhancement is possible late day 2 or more likely day 3 (22nd). This is due to the arrival of fast winds from CH02/- and CH01/-. Initially Unsettled to Active geomagnetic activity but becoming Quiet, isolated Unsettled later day 1 (20th). Increasing to Unsettled to Active with isolated G1/Minor Storm intervals likely, with the arrival of the fast wind, either late day 2 (21st) or more likely day 3 (22nd). Activity easing back to Quiet to Unsettled day 4 (23rd).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is likely to remain at background levels. The high energy electron flux (greater than 2 MeV) is forecast to continue rising as solar winds ease, due to the recent enhancement with Moderate to High levels likely, before dropping out with any fast wind arrival late day 2 or day 3 (21st or 22nd). Flux levels rising again day 4 (24th). The associated fluence is likely to rise to Active late day 1 or day 2 (20th or 21st), easing day 3 (22nd), before rising again day 4 (23rd).

Figure 1. Solar Analysis Valid 19/2000 UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - γ - δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There are no further CME arrivals expected at Earth.

The current slightly elevated solar winds are expected to gradually ease day 1 (20th) as recent CME and fast wind influence subsides. The next notable enhancement will likely be the arrival of the fast wind of CH02/-, followed by CH01/-. These two features appear more intense and have extended both equator-ward and eastward compared to the previous rotation. Consequently arrival is anticipated earlier than persistence indicates, most likely late day 2 (21st) or day 3 (22nd). This is supported by MOSWOC Enlil, which suggests peak solar winds speeds on the 22nd, although this does transition into the fast wind earlier than is expected.

Geomagnetic activity is forecast to be Unsettled to Active at first, but becoming Quiet, isolated Unsettled later day 1 (20th). Increasing to Unsettled to Active with isolated G1/Minor Storm intervals likely with the arrival of the coronal hole fast wind, either late day 2 (21st) or more likely day 3 (22nd). Activity easing back to Quiet to Unsettled day 4 (23rd).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	10	30	60	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Observed Solar winds at L1, with distinct magnetic cloud structure observed.

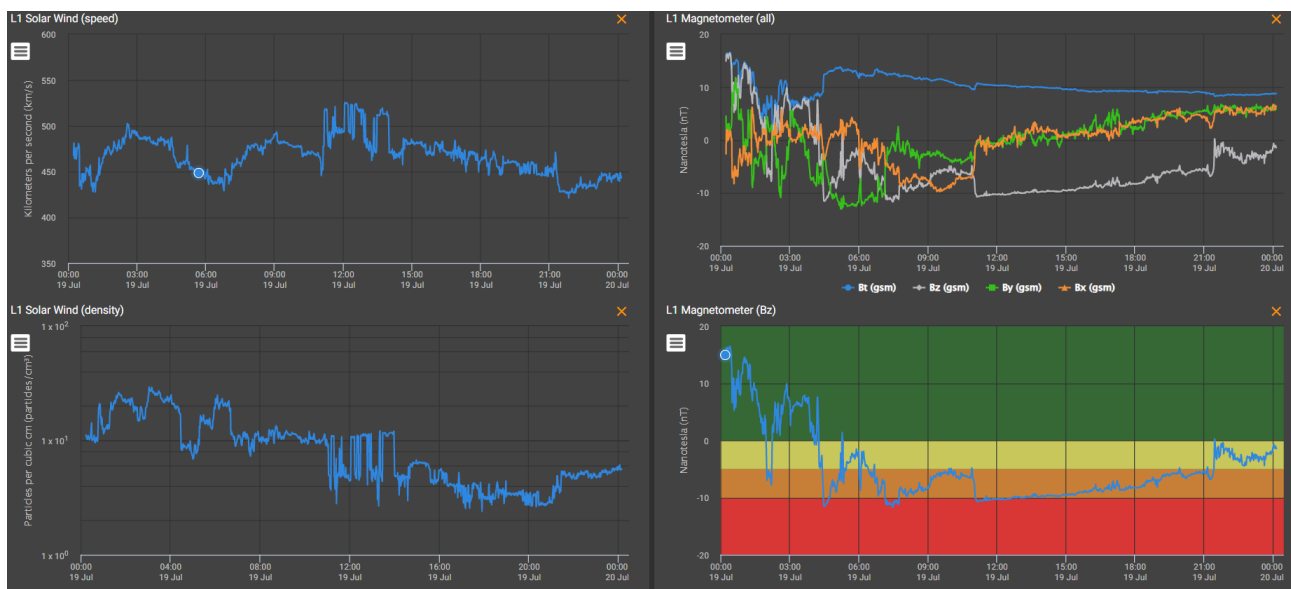


Figure 3: Solar Wind Persistence Model, showing enhancement on 23rd on previous rotation.

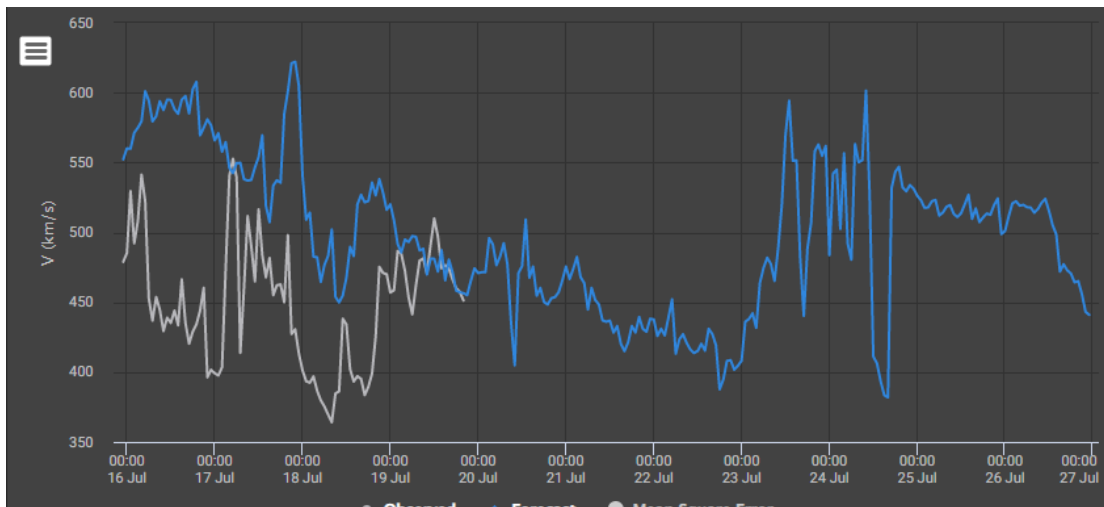
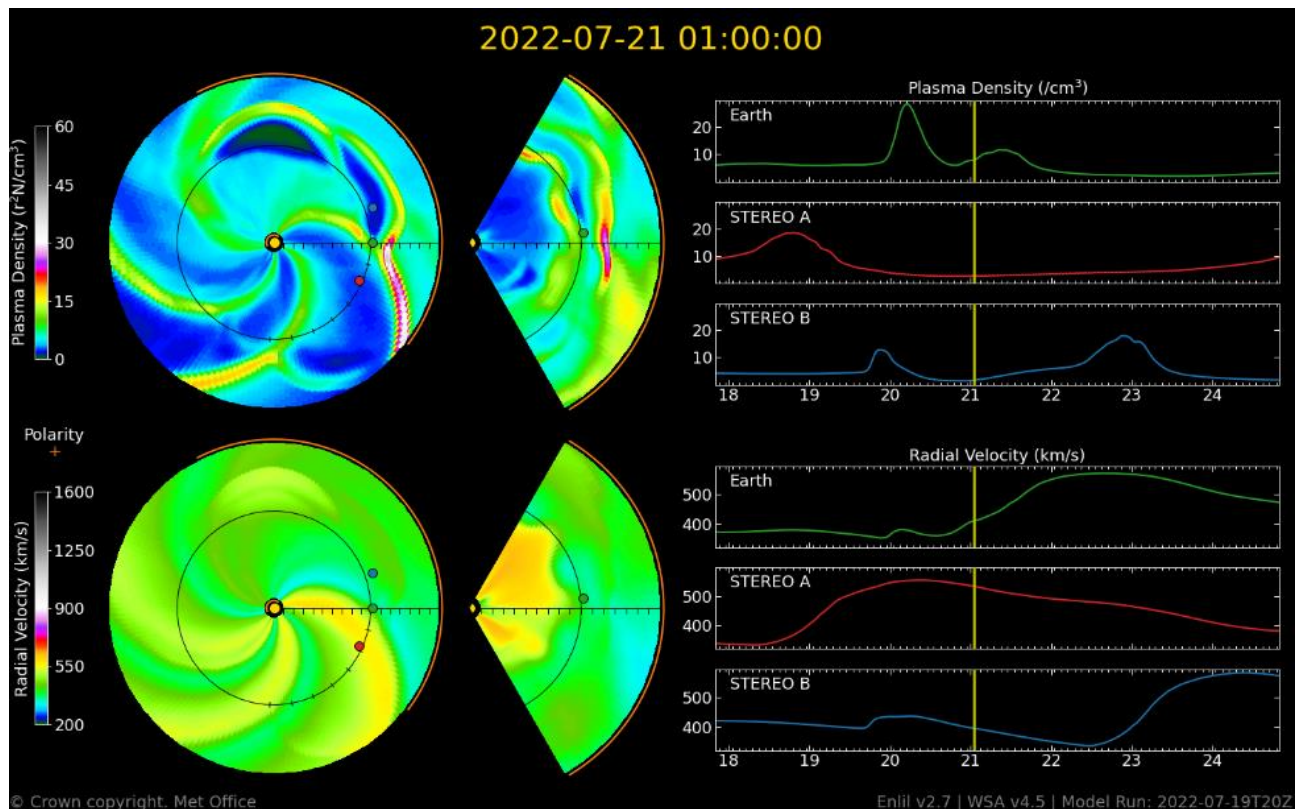


Figure 4: Enlil showing transition into fast wind on 21st, peaking 22nd.



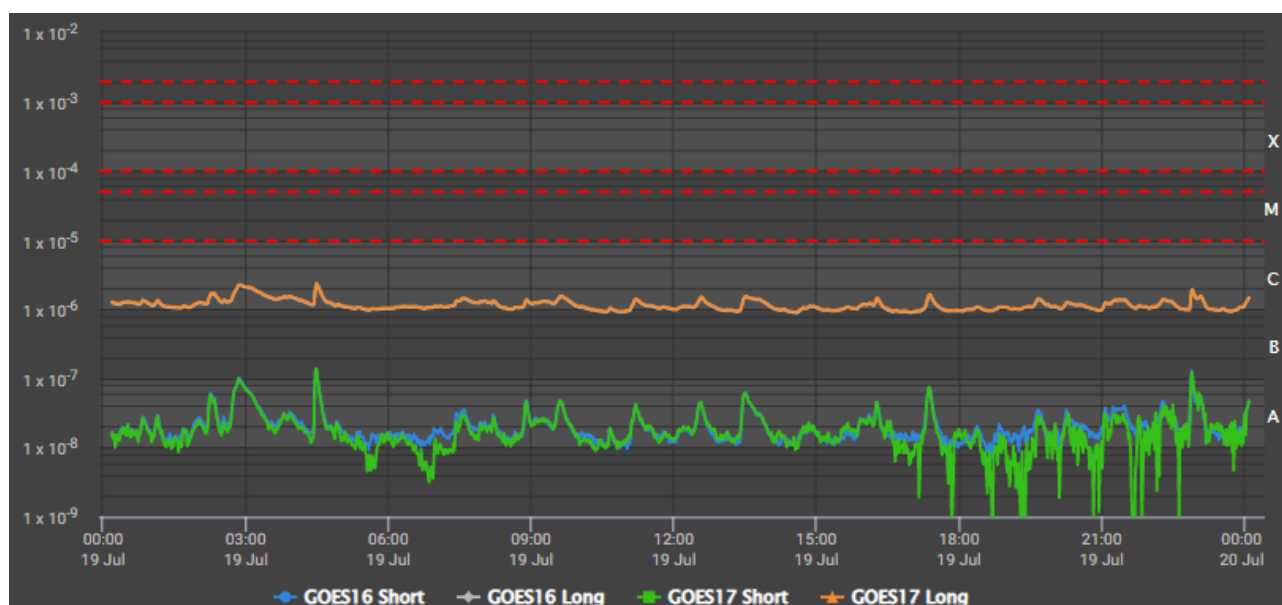
Radio Blackouts - X-Ray Flares:

Solar activity is currently Low, with the observed X-ray flux by GOES persisting at around C-class, with a number of small C1/C2 flares occurring. There are nine sunspot regions on the visible disc, six of which are currently numbered, however these are generally all small and either decaying or exhibiting little growth. The main flare activity is from AR3056 Cri/Beta in the southwest and AR3057 Csi/Beta in the northwest. Of the three unnumbered regions, the only growth is currently being observed in the two regions in the northeast.

With the large number of sunspots on the disc, Low activity is expected to be maintained through the period, with an ongoing chance of isolated M-flares increasing this to Moderate.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	20	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES 16/17 X-ray Flux



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at background levels. There is the potential for proton flux increasing, due to the number of sunspot regions on the Earth-facing disc, including regions on or just over the west limb. However, these only give a very slight chance of proton flux reaching the S1 level (10 pfu).

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	2	2	2	2
Very Active	$\geq \text{S3}$ *	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)						

High Energy Electrons Event ($\geq 2 \text{ MeV}$):

The high energy (greater than 2MeV) electron flux as measured by GOES-16 has been mostly at background due to the recent CME and fast wind arrival, but has recovered to Moderate as solar winds eased. With further rising values possible through day 1 (20th) and day 2 (21st), before the arrival of the next fast wind enhancement, Moderate to High levels are likely to be observed and exceeding the alert level at times (1000 pfu). A further dropout is then likely either late day 2 or day 3 with the onset of this next fast wind enhancement, however this fast wind is subsequently also likely to also enhance electron flux populations in the Van Allen Belts, with high flux returning through day 4 (23rd),

The associated 24 hour fluence is currently below the Active threshold, but likely to rise day 1 (20th) approaching the Active threshold, likely later in the day, and through day 2 (21st). This risk recedes with the onset of the fast winds of CH02 and CH01 and any subsequent dropout, before likely returning day 4 (23rd). REFM is giving poor guidance, as this is likely not accounting for the recent observed solar wind enhancement.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	40	50	30	40
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: GOES-16 Electron Flux (top) and Fluence with REFM (bottom)

